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Final Report for ONR N000149810065

Private Investigator: Russ E. Davis

Period of: 10/1/97 - 9/30/2000

The objective of this grant was to directly observe the vertical velocity, temperature and salinity fields in the Labrador Sea during the wintertime convection season in order to understand the process of water-mass formation and to test and improve numerical models of the process. The effort achieved its technical goals with respect to observations and has generated considerable debate, if not yet understanding, about the processes by which convection brings about change of deep-water masses.

A total of 10 Vertical Current Meter floats built under this grant, and 4 from a predecessor grant, were deployed to observe over the winter of 1998. Added to 16 such float deployed the previous year under the predecessor grant and 30 floats prepared by collaborator Breck Owens of Woods Hole Oceanographic Institution, this provide an unprecedented view of the deep convection process. The data is of high quality and the data return was high considering the extreme winter conditions these instruments had to survive.

The instruments observed vigorous deep convection over the winter of 1997 and rather less vigorous convection the second year. The data has been fully analyzed. Although not the primary objective, the horizontal drift of the instruments contributed to a remarkable analysis of the mid-depth circulation of the Labrador and Irminger Seas that disclosed a previously unexpected countercurrent offshore of the deep West Greenland and Labrador Currents. This study "Mid-depth recirculation observed in the interior Labrador and Irminger Seas by direct velocity measurements" was published by Lavender, Davis and Owens in Nature. The ability to reproduce this odd counter current will pose a significant test on the ability of models to simulate processes in the region.

The main work of the floats was to diagnose the processes by which convection forms intermediate depth waters. Signals characteristic of classical convection plumes were observed and described, but these small-scale (order hundreds of meters horizontal scale) do not appear to be responsible for more than half the vertical heat flux accompanying convection. The results indicate that larger-scale, perhaps mesoscale, motion are responsible for a significant part of the vertical flux but the log time scale of these motions makes gathering conclusive statistical proof impossible even with our extensive array. These results have been submitted for publication to the Journal of Physical Oceanography in the paper "Observation of open-ocean deep convection in the Labrador Sea from subsurface floats" by Lavender, Davis and Owens.